Unanticipated inflation and government finance

van der Ploeg, F.

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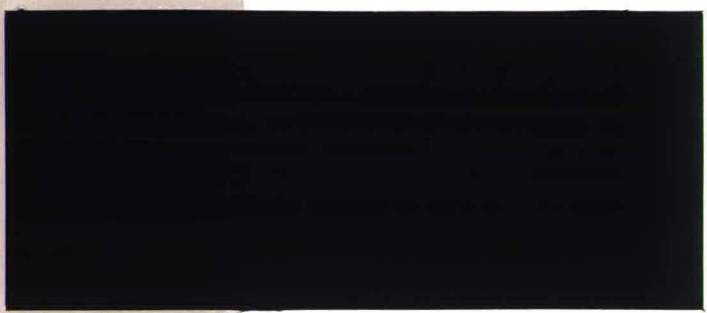

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by Frederick van der Ploeg

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Frederick van der Ploeg *†

February, 1991

CentER, Tilburg University and CEPR

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†Mailing address: P.O. Box 90153, 5000 LE Tilburg, The Netherlands.

Abstract

The merits of an independent EuroFed are discussed within the context of a tax/seigniorage smoothing model for a monetary union. There is an incentive to use a surprise inflation tax to wipe out the real value of government debt and of wage contracts, because this allows a cut in distortionary taxes and a boost to employment and private consumption. If dependent central banks can pre-commit, there is no case for an independent EuroFed as this leads to a sub-optimal government revenue mix. However, if only an independent EuroFed can guarantee sufficient discipline, a case can be made for it over and above a monetary union with a non-cooperative or cooperative central bank. This case is stronger when the aversion to inflation is high, when the outstanding stock of nominal government debt is high, when the underground economy is insignificant and when there is not much wage indexation. Even if all contracts are indexed, there is an incentive for unanticipated inflation if money demand depends on expected inflation. However, if private agents are rational in their forecasts of inflation, government spending is financed through temporary bouts in taxation and inflation and, given that all contracts are indexed, no case for an independent central bank can be made. Competition between central banks of a monetary union induces excessive inflation, because each bank fails to internalise the externalities associated with appropriating too much seigniorage from the common central bank.

JEL classification: 311, 320, 430
Keywords: EuroFed, monetary union, credibility, unanticipated inflation, tax/seigniorage smoothing, international policy coordination

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1 Introduction

In Europe steps are under way for the construction of an economic and monetary union (EMU). This should lead to the removal of physical, technical and administrative barriers to international trade in goods, factors of production and financial assets. Much progress has already been made in establishing a free-trade zone. The 1989 Delors Report and the 1990 Report of the Commission of the European Community also argue for the establishment of an independent European System of Central Banks (ESCB):

> "This new System would have to be given the full status of an autonomous Community institution ... the System would be committed to the objective of price stability ... the ESCB Council should be independent of instructions from national governments and Community authorities; to that effect the members of the ESCB Council, both Governors and the Board members, should have appropriate security of tenure" (Delors Report, 1989, article 32).

In contrast to the Banca d'Italia or the Bank of England the European Central Bank, called the EuroFed, should be free of political pressures and thus have an independent status. The EuroFed should thus be much more like the Bundesbank [1] or De Nederlandsche Bank, because both these institutions have an excellent anti-inflation discipline and are mostly free of pressures to accommodate demands for more government spending or higher

[1] In fact, the Delors Report advocates a federal structure in which the national central banks are incorporated in a ESCB. The ESCB should have three levels of organisation: (i) the Council of the ESCB consisting of the presidents of the national central banks, which are independent of the Community and national authorities (cf. the German Zentralbankrat); (ii) the Board of the ESCB, which monitors monetary developments and oversees the implementation of the common monetary policy (cf. the Direktorium); and (iii) the national central banks which execute the decisions taken by the Council (cf. the Landeszentralbanken).

wage demands. This paper assesses the case for an independent common central bank (say the EuroFed) for a monetary union (say the EMU) within the context of a simple tax/seigniorage smoothing model. Since the case for an independent common central bank depends on its ability to pre-commit itself to announced monetary policies, it is essential to allow for an incentive to have a surprise inflation tax. This paper allows for the issue of **nominal** government debt, in which case the monetary authorities have an incentive to levy an unanticipated inflation tax in order to reduce the real value of debt service, and for the presence of **nominal** wage contracts, in which case there is an incentive to use surprise inflation to boost employment.

To illustrate the argument, attention is first focussed on the monetary discipline an independent central bank can offer in safe-guarding the real value of government debt. This is probably the most important source of time inconsistency for Europe, but of course the arguments in favour of an independent common central bank can also be made in terms of removing the incentive to use unanticipated inflation to erode the real value of the predetermined nominal wage and thus engineer a transitory gain in employment (along the lines of Barro and Gordon, 1983). However, wage indexation has been quite common in Europe, so this may limit the possibility of using an unanticipated monetary expansion for this purpose. Much work has been done on the stabilisation aspects of monetary unification and relatively little work has been done on the allocative and public-finance aspects of a monetary union. It therefore seems worthwhile to also focus on the incentive to wipe out the real value of government debt. Of course, the first-best policy is to destroy such incentives to renege on optimal contracts altogether through the issue of indexed rather than nominal bonds and through indexation of all other contracts.

Section 2 sets up a simple model of tax/seigniorage smoothing in a monetary union where governments have to rely on the issue of nominal debt. This model is based on the work of Gros (1988), who developed a similar model to decide whether it is optimal for a small country to enter or stay out of the European Monetary System. Section 3 looks at the situation where the governments can pre-commit to announced policies, because they are trusted by private agents. Absence of international cooperation among the governments of the monetary union then leads to excessive inflation and monetary growth throughout the region and to too low tax rates, because each country fails to internalise the adverse effects of appropriating more seigniorage from the common central bank on the common inflation rate. Section 4 examines the situation where governments are not believed to

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have sufficient monetary discipline and thus cannot pre-commit. This leads to higher inflation and lower conventional tax rates in equilibrium than when the central banks can pre-commit, because governments cannot resist the temptation to wipe out the real value of debt service and the private sector realises this. In such a situation it is also possible to construct an example in which international policy coordination is counterproductive. Section 5 shows that, if central bankers have sufficient monetary discipline, an independent common central bank comes off worst from the welfare point of view because it leads to a sub-optimal government revenue mix with too high conventional tax rates. However, if central bankers are known to succomb to pressures to levy a surprise inflation tax, a case for an independent common central bank can be made, especially when the outstanding stock of nominal government debt in the monetary union is high, when the aversion to inflation is high, and when the costs of collecting conventional taxes is (due to the absence of a well-developed black economy) low. Section 6 extends the analysis to allow for the effects of unanticipated inflation on unemployment, output and private consumption and shows that this reinforces the case for an independent common central bank. This section also integrates the positive "screw-up" theories of inflation with the public-finance theories of tax/seigniorage smoothing and thus provides a rationale why the policy of eridicating all labour-market distortions may not be first-best when there is a need to finance public goods.

The time inconsistency problems discussed in Sections 2-6 can be avoided when governments issue indexed debt and wage contracts include indexation clauses. However, if the velocity of circulation depends positively on the nominal interest rate and money demand depends negatively on the expected inflation rate, an additional source of time inconsistency arises. Section 7 shows that the optimal inflation rate is lower than under the quantity theory of money, because governments now take account of citizens economising on holdings of money. Absence of international policy coordination leads to excessive inflation and to too low tax rates. Since it reduces the base for raising seigniorage revenues, tax rates do not fall as much as they would otherwise. Lack of monetary discipline leads to a higher optimal inflation rate, because agents do not trust the independent common central bank not to repudiate. The case for an independent common central bank is thus strenghtened when one takes account of nominal interest rates and expected inflation on money demand. Section 8 builds on Obstfeld (1991a,b) and discusses the micro foundations of the ongoing strategic interactions between the governments and private agents of a monetary union. This leads to the

exciting insight that, even though it is optimal to smooth intratemporal distortions and let tax rates and inflation rates go up and down together, it is no longer optimal to smooth intertemporal distortions in the sense that tax and inflation rates need no longer follow random walks. Instead, a permanent increase in government spending leads to a temporary bout of inflation and a temporary increase in tax rates which allows a build-up of government assets. The idea is that the resulting increase in interest income eventually finances the increase in spending without any distortions. This section also extends the analysis to ensure that in steady state full liquidity and Friedman's optimum quantity of money prevails and shows that, given that all contracts are indexed, no case can be made for an independent central bank. Section 9 concludes with a summary of results.

2 A monetary union with nominal government debt

The monetary union consists of N member states, denoted by the subscripts $i = 1, \ldots, N$. For simplicity, purchasing power parity holds throughout the monetary union. Because exchange rates are irrevocably fixed, there must be a common inflation rate throughout the region. The treasury of member state i has a primary budget deficit, which is defined as the excess of exhaustive government spending (g_i) over tax revenues (τ_i). Its full deficit includes interest payments on outstanding nominal treasury debt ($r_i d_i$) and must be financed by selling treasury debt ($\dot{d}_i$) or by seigniorage revenues (s_i). The flow budget identities of the treasuries can thus be written as

$$\dot{d}_i + s_i = g_i - \tau_i + r_i d_i, \quad i = 1, \ldots, N, \tag{1}$$

where all quantity variables are expressed as fractions of the full-employment level of national income and r_i denotes the growth-corrected ex-post real interest rate of country i. As long as individual treasuries remain solvent, they are free to borrow and lend on the open market at a given rate of interest. Solvency requires that treasury debt does not grow at a rate faster than the interest rate in the long run. If this is the case, one obtains the present-value budget constraints of the treasuries:

$$r_i d_i + g_i^P \leq \tau_i^P + s_i^P, \quad i = 1, \ldots, N \tag{2}$$

where the permanent level of exhaustive government spending is defined as

$$g_i^P(t) \equiv r_i(t) \int_t^\infty \exp[-\int_t^v r_i(v')dv']g_i(v)dv$$

and τ_i^P and s_i^P are defined similarly. Hence, solvency requires that the current level of treasury debt plus the present value of the stream of future exhaustive government spending must not exceed the present value of future tax and seigniorage revenues.

The member states of the monetary union collect seigniorage from the common central bank. The bank obtains its funds from printing money, because private agents hold money without getting a return on it. The budget constraint of the common central bank is thus given by

$$\left(\sum_{i=1}^{N} s_i\right) = \theta m N \tag{3}$$

where θ denotes the common monetary growth rate of the region and m denotes the holdings of real money balances by an individual country. For simplicity, the velocity of circulation and thus m are the same and constant for each country of the monetary union. The quantity theory of money thus holds for the region and says that common rate of inflation (π) is determined by the excess of monetary growth (θ) over the exogenous growth in full-employment real income (n):

$$\pi = \theta - n. \tag{4}$$

The expected or ex-ante (growth-corrected) real interest rate (ρ), the real interest rate for short, is according to the Fisherian hypothesis determined by common consumption tastes and production technologies throughout the region, more or less exogenous and in any case independent of expected inflation rates. For given tastes and production technologies, any change in nominal interest rates must then be due to a change in expected inflation

rates. Since treasuries guarantee a nominal rate of return, the realised or ex-post real interest rates are relevant for the borrowing and lending activities of the treasuries:

$$r_i = \rho + \pi_i^e - \pi_i \tag{5}$$

where π_i^e denotes the expected inflation rate in country i. The ex-post real interest rate decreases with unanticipated inflation, which is one way in which governments can reduce the level of their inflation-corrected deficits and thus reduce the growth of their debt-GDP ratios [2].

Finally, the presence of integrated capital markets throughout the monetary union, the absence of capital controls and risk-neutral arbitrage ensure that nominal interest rates, ex-post real interest rates and expected inflation rates are equalised throughout the region:

$$r_i = r, \quad \pi_i = \pi, \quad \pi_i^e = \pi^e, \quad i = 1, \ldots, N. \tag{6}$$

Each treasury wishes to employ the most efficient revenue mix for financing a given stream of exhaustive government spending. Each treasury minimises the excess burden associated with raising tax and seigniorage revenues. The dead-weight losses correspond to the familiar welfare triangles and are proportional to real output [3], hence the welfare-loss function of treasury i corresponds to:

[2] Since d_i is not a predetermined variable, an unanticipated increase in the level rather than the growth rate of the money supply induces a corresponding increase in the price level and can thus be used to wipe out the real value of treasury debt "at the stroke of a pen". This paper is concerned with unanticipated changes in inflation, because unanticipated changes in the level of the money supply correspond to capital levies and are somewhat unrealistic.

[3] It is difficult to justify the costs of inflation in terms of triangles under the money demand schedule, since under the quantity theory this schedule is flat and the empirical magnitude of these costs are fairly small anyway. However, there are many other reasons why inflation is costly and should affect the welfare loss of a government (Fischer and Modigliani, 1975). For example, a higher level of anticipated inflation may induce a higher variance of inflation which (in the absence of indexation) causes a misallocation of

$$W_i \equiv \frac{1}{2}\int_0^{\infty} \exp(-\rho t)[\tau_i(t)^2 + \beta\pi(t)^2]dt, \quad \beta > 0. \tag{7}$$

It is possible to distinguish between cooperative outcomes (denoted by a superscript C) and non-cooperative outcomes (denoted by a superscript N). If the governments of the member states do **not** cooperate, each government chooses a time-path of tax and seigniorage rates (τ_i and s_i) to minimise the welfare loss function (7) subject to equations (1)-(6), taking the tax and seigniorage rates of rival governments (τ_j and $s_j, j \neq i$) as given. The resulting non-cooperative outcome corresponds to a Nash-Cournot equilibrium. If the governments do cooperate and have an equal say in running the common central bank, they **jointly** choose $\{\tau_i, s_i, i = 1, \ldots, N\}$ to minimise the total welfare loss $(W_1 + W_2 + \ldots W_N)$.

Following Barro and Gordon (1983) and Barro (1983), it is also possible to distinguish between rules or pre-commitment outcomes (denoted by the superscript R) and discretion or no-commitment outcomes (denoted by the superscript D). With rules the individual governments and the common central bank can be trusted not to use a surprise inflation tax to wipe out the real value of government deficits. Private agents then believe what the authorities announce about monetary policy and thus the expected rate of inflation coincides with the actual rate of inflation. Furthermore, with rules the national governments can minimise their welfare loss under the constraint $\pi^e = \pi$. The rules outcome then corresponds to the situation where treasuries issue real or indexed bonds. With discretion governments cannot be trusted to levy a surprise inflation tax. Hence, when they minimise their welfare loss, they have to take the expected inflation rate as given. Of course, in rational expectations equilibrium expectations cannot be falsified so ex post $\pi^e = \pi$ must hold. In summary, there are four outcomes: NR, CR, ND and CD.

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resources, arbitrary redistributions and fewer long-term contracts. An alternative justification of (7) is given in Sections 6 and 8, whilst Section 7 allows for a downward-sloping money demand schedule.

3 Rules: Competition leads to excessive inflation

Here the rules outcomes are considered. A non-cooperative monetary union leads under rules to

$$\tau_i^{NR} = \left(\frac{\beta}{mN}\right)\pi^{NR}, \quad \dot{\tau}_i^{NR} = 0, \quad i = 1, \ldots, N, \tag{8}$$

whilst a cooperative monetary union leads to

$$\tau_i^{CR} = \left(\frac{\beta}{m}\right)\pi^{CR}, \quad \dot{\tau}_i^{CR} = 0, \quad i = 1, \ldots, N. \tag{9}$$

Fundamental properties of both the cooperative and the non-cooperative outcomes are that conventional tax rates are smoothed over time (cf. Barro, 1979), that the common inflation rate is smoothed over time, and that tax and seigniorage revenues must go up and down together (cf. Mankiw, 1987; Grilli, 1989). The point is that the marginal distortions from the various current and future sources of raising revenues must be equalised [4]. There is a trade-off between aiming for zero tax distortions and aiming for zero inflation (or full liquidity) which leads in equilibrium to both positive tax rates and positive inflation rates (cf. Phelps, 1973).

Since there is a common inflation rate throughout a monetary union, the optimal rules of public finance require that the tax rates must be the same throughout the region as well, even though levels of exhaustive government spending and of government debt may vary from country to country. Obviously, this requires considerable solidarity in a monetary union. If there are two countries, the first with a higher level of permanent government spending and government debt and the second with a smaller need for government revenues ($\rho d_1 + g_1^P > \rho d_2 + g_2^P$), the first country obtains more

[4] This tax-smoothing result depends on the rate of time preference being the same as the market rate of interest. If governments face a strictly positive probability of being removed from office, their rate of time preference may exceed the interest rate in which case tax and inflation rates increase over time. Short-sighted politicians thus postpone raising conventional tax and seigniorage revenues.

seigniorage from the common central bank than the second country [5]. A monetary union is thus only sustainable when countries with little need for government revenues transfer revenues to countries with a greater need; otherwise the fixity of nominal exchange rates is threatened. It can easily be shown that when the costs of tax collection or, alternatively, the size of the black economy are much larger in one country (smaller value of β), then tax rates are lower than the average and consequently the country also receives an implicit transfer of seigniorage revenues from the other countries. It is therefore understandable that both the Delors Report and the Report of the European Commission recommend a convergence of levels of government spending and debt. The distribution of seigniorage according to need is otherwise the political price one has to pay for monetary unification. Pessimists (or realists) might argue, of course, that such redistributions are politically unlikely so that there is a danger that a monetary union will not be established unless convergence in fiscal needs is achieved.

Upon substitution of equations (8) and (9) into the treasuries' present-value budget constraints (2), one obtains a comparision of the non-cooperative and cooperative outcomes under rules:

$$\pi^{NR} = \left(\frac{\rho d + g^P - n m}{(\beta/mN) + m}\right) > \pi^{CR} = \left(\frac{\rho d + g^P - n m}{(\beta/m) + m}\right) \tag{10}$$

$$\tau^{NR} = \left(\frac{\rho d + g^P - n m}{1 + (m^2 N/\beta)}\right) < \tau^{CR} = \left(\frac{\rho d + g^P - n m}{1 + (m^2/\beta)}\right) \tag{11}$$

where $g^P \equiv \left(\sum_{i=1}^{N} g_i^P\right)/N$ and d and τ are defined similarly. An insight, relevant for both the cooperative and non-cooperative outcomes, is that treasuries must raise conventional tax and seigniorage revenues for permanent increases in government spending and borrow for temporary increases in government spending. For example, governments should borrow for investment projects with a market rate of return (as they leave the permanent level of exhaustive government spending, net of revenues from investment

[5] Within the context of a different model of a monetary union with externalities, Casella (1990) shows that a small economy will in general obtain more than proportional power in the cooperative agreement and thus will obtain a transfer of seigniorage revenues in equilibrium.

projects, unaffected but increase the actual level of spending). The size of the outstanding average stock of government debt is irrelevant for the size of the growth-corrected government deficits. The proportion of conventional tax revenues increases when the aversion to inflation (β) increases or, alternatively, when the costs of tax collection decrease.

Comparision of equations (8) and (9) shows that the marginal distortion from the collection of seigniorage revenues is N times as large under the cooperative as under the non-cooperative outcome. Absence of international policy coordination means that each country fails to internalise the adverse effects of grabbing more seigniorage from the common central bank on the other countries of the monetary union. Conflict between the national ministries of finance thus leads to excessive monetary growth and inflation and to too low conventional tax rates. For time-invariant paths of government spending, it is easy to compare the welfare losses under the non-cooperative and cooperative outcomes:

$$\begin{aligned} W^{NR} &= \left(\frac{\beta}{2\rho}\right)(\rho d + g - nm)^2 \left(\frac{\beta + (mN)^2}{(\beta + m^2 N)^2}\right) \\ &> W^{CR} = \left(\frac{\beta}{2\rho}\right)(\rho d + g - nm)^2 \left(\frac{\beta + m^2}{(\beta + m^2)^2}\right) \end{aligned} \tag{12}$$

as long as $N > 1$ and $\beta > 0$. Clearly, if pre-commitment to announced policies is feasible, international cooperation leads to lower monetary growth, lower inflation, higher tax rates, and higher welfare.

4 Discretion: Policy coordination can be counterproductive

Now the no-commitment or discretion outcomes are considered. Each government thus has to take as given that it cannot influence the expected rate of inflation through announcements about policy, as they would not be believed by private agents. Equations (8) and (9) are then replaced by:

$$\tau_i^{ND} = \left(\frac{\beta}{mN + d_i}\right)\pi^{ND}, \quad \dot{\tau}_i^{ND} = 0, \quad i = 1, \ldots, N \tag{8'}$$

$$\tau_i^{CD} = \left(\frac{\beta}{m + d_i}\right)\pi^{CD}, \quad \dot{\tau}_i^{CD} = 0, \quad i = 1, \ldots, N. \tag{9'}$$

Intertemporal smoothing of tax and seigniorage revenues is still optimal. Also, these two sources of revenues should still go up and down together. The main difference with the rules (or pre-commitment) outcome is that the marginal benefit of inflation has increased, because the ex-ante base for raising seigniorage revenues now includes nominal government debt as well as money balances. This is why the optimal proportion of conventional tax to seigniorage revenues has decreased. The effects of this become clear upon substition of equations (8') and (9') into (2) and imposing equilibrium:

$$\pi^{ND} = \left(\frac{\rho d + g^P - nm}{m + \beta/(mN + d)}\right) > \pi^{CD} = \left(\frac{\rho d + g^P - nm}{m + \beta/(m + d)}\right) \tag{10'}$$

$$\tau^{ND} = \left(\frac{\rho d + g^P - nm}{1 + m(mN + d)/\beta}\right) < \tau^{CD} = \left(\frac{\rho d + g^P - nm}{1 + m(m + d)/\beta}\right). \tag{11'}$$

Note that, given absence of pre-commitment, non-cooperation leads to excessive inflation and to too low tax rates. The presence of an outstanding stock of nominal government debt is an open invitation to wipe it out with an unanticipated inflation tax. Since in the absence of pre-commitment governments cannot be trusted not to take up the invitation, inflation and seigniorage revenues are higher under discretion than under rules ($\pi^{ND} > \pi^{NR}$ and $\pi^{CD} > \pi^{CR}$ if $d > 0$). This must mean, of course, that conventional tax rates are lower when pre-commitment to announced monetary policies is not feasible ($\tau^{ND} < \tau^{NR}$ and $\tau^{CD} < \tau^{CR}$ if $d > 0$). As far as treasuries are concerned, lack of monetary discipline and competition between governments (ND) is excellent as this reduces conventional tax distortions more than any other outcome. However, as far as central bankers are concerned, this is the worst outcome because it increases inflation more than any other outcome. It is clear that central bankers are most happy when there is an excellent monetary discipline and international policy coordination (CR) because then inflation is lower than in any other outcome. This seems to capture in a nutshell the conflict between ministers of finance and central bankers.

If the monetary authorities do not have a high enough reputation and cannot pre-commit to announced policies, it is possible that macroeconomic policy coordination within a monetary union can be counterproductive. Previously such a counterintuitive result has been obtained for a regime of floating exchange rates when the monetary authorities are tempted to use surprise inflation to either erode the real value of predetermined nominal wages and boost employment (Rogoff, 1985) or to use the seigniorage revenues thus obtained to reduce distortionary taxes and increase spending on public goods (van der Ploeg, 1988). Under floating exchange rates cooperation destroys monetary discipline and leads to higher inflation and lower welfare, because an unanticipated monetary expansion no longer induces a depreciation of the nominal exchange rate and an increase in consumers' prices. International policy coordination leads to the disappearance of this disincentive to levy a surprise inflation tax, because when all countries renege simultaneously the nominal exchange rate is unaffected. In a monetary union international policy coordination can also be counterproductive, but the explanation is a bit more subtle as exchange rates are fixed. The following counter-example makes the point.

Assume that the government run up assets equal to the stock of money balances, $d = -m$. It then follows that $\pi^{CD} = 0 < \pi^{ND}, \tau^{CD} = \rho d + g^P - nm > \tau^{ND}$ and $W^{CD} = (\frac{1}{2\rho})(\rho d + g^P - nm)^2$. It is straightforward to show that then $W^{CD} > W^{ND}$ holds if the inequality $\beta(N-3) < m^2(N-1)$ holds. Sufficient conditions for the CD-outcome to be worse than the ND-outcome, given that $d = -m$, are $N = 2, N = 3$ or $\beta < m^2$. Macroeconomic policy coordination can, under certain circumstances, worsen monetary discipline and be counterproductive. This perverse result is more likely to occur when the advantage of international cooperation in the form of lower inflation is outweighed by the disadvantage of more tax distortions (low β) and when the number of countries is small. The counter-example can best be understood by thinking of a clever scheme for restructuring government debt which eliminates the incentives for unanticipated inflation in the cooperative outcome: hold a stock of nominal bonds bought from the public equal to the private sector holdings of real money balances so that when a government reneges, it looses just as much on its assets as it gains on real money balances. In the non-cooperative outcome there is still an incentive to renege leading to higher inflation, but this may be desirable when the costs of tax collection are high enough.

5 The case for an independent common central bank

Most practitioners advocate that a central bank should be independent and free of political pressure. Its sole objective should be directed at maintaining price stability. One way of thinking about an independent central bank is that it is staffed by ultra-conservative central bankers who act as an agent for the government and give an infinite weight to the objective of price stability. The optimal public-finance rules for a monetary union with an independent common central bank (denoted by the superscript I) are given by $\pi^I = 0$ and $\dot{\tau}_i^I = 0,\ i = 1, \ldots, N$. Upon substitution into the present-value budget constraints, one obtains

$$\tau_i^I = \rho d_i + g_i^P - nm, \quad i = 1, \ldots, N. \tag{13}$$

An independent common central bank achieves a stable price level, which means that the ministries of finance need to resort to higher tax rates than would be the case when they have a say in the running of the central bank. If the various governments enjoy the trust of private agents, they can pre-commit and it can easily be shown that $W^I > W^{NR} > W^{CR}$. Hence, if policies are credible, the lowest welfare loss is achieved when the various ministers of finance coordinate their budgetary and monetary policies and the highest welfare loss occurs when there is an independent common central bank. The reason is, of course, that an independent bank leads to a sub-optimal government revenue mix.

Why then do practitioners advocate an independent central bank? Why does the Delors Report recommend an independent European System of Central Banks based on the German model? The main reason is that they do not trust that treasuries have sufficient monetary discipline to guarantee price stability, because they forever have the temptation to levy an unanticipated inflation tax in order to finance additional spending, or to accommodate demand for higher wages. Practitioners believe that only an independent common central bank, directed by ultra-conservative central bankers who only care about price stability, will not be tempted to use a surprise inflation tax to wipe out the real value of outstanding nominal government debt (cf. Gros, 1988), the real value of predetermined nominal wage contracts (cf. Barro and Gordon, 1983) or the real value of money balances

(cf. Calvo, 1979; Barro, 1983). Whenever the central bank does give in to such temptations, equilibrium inflation will be higher and tax rates will be lower. Since ministers of finance, trade unions and others anticipate that an independent central bank is not going to give in to their demands, they settle for less and as a result inflation is lower and tax rates are higher. Undoubtedly, this is the reason why central bankers (the main signatories of the Delors Report) are so much in favour of an independent EuroFed.

In the light of the above discussion, it is much more relevant to compare non-cooperative and cooperative outcomes under discretion, which is relevant when ministers of finance have a say in the running of the central bank, with the outcome which prevails under an independent common central bank. To assess the case for an independent common central bank, one should therefore trade-off the disadvantage of a sub-optimal government revenue mix against the advantage of excellent monetary discipline and the lower inflation this brings with it. The condition under which an independent common central bank (I) yields higher welfare than a cooperative monetary union which is unable to pre-commit (CD) is given by

$$(\beta - m^2)d(m+d) > (\beta + m^2)m(m+d) \tag{14}$$

whilst the condition under which one prefers an independent common central bank over a non-cooperative monetary union with a dependent central banking system (ND) is given by

$$(\beta - m^2)d > [\beta(2-N) + Nm^2]m. \tag{15}$$

Inequality (14) suggests that one is more likely to come out strongly in favour of an independent common central bank rather than a cooperative monetary union when the stock of outstanding nominal government debt is high, when the priority governments attach to the elimination of inflation rather than tax distortions is high, and when the size of the underground economy is small. Inequality (15) is more (less) likely to be violated as the number of members of the monetary union increases, provided that β exceeds (is less than) m^2. In other words, when the priority one attaches to price stability exceeds the priority one attaches to the elimination of tax distortions and the number of members is large, one always prefers an independent common

central bank to a non-cooperative monetary union with a dependent central banking system.

Italy has a larger black economy and a less efficient tax system (lower β) than Germany and should therefore find it optimal to extract relatively more revenues from seigniorage than from conventional taxation (cf. Canzoneri and Rogers, 1990). Some even argue that such differentials in the need for public revenues provide a good case against the EMU and an argument in favour of a crawling peg between the currencies of northern and of southern Europe as this would accommodate the required inflation differential (e.g. Dornbusch, 1988). However, this argument completely ignores the monetary discipline the Bundesbank gives to the Banca d'Italia under the EMS (Giavazzi and Pagano, 1988). The same point applies to the EMU: the EuroFed should provide the monetary discipline which the central banks of some member states may otherwise lack. The gain in central bank credibility and the accompanied tying of one's hands may be the main advantage of the EMS, and hopefully of the EuroFed and the EMU as well. This advantage of a strong Bundesbank in the EMS and an independent EuroFed is particularly relevant for countries with a large stock of outstanding nominal government debt, such as Italy and the Netherlands, and with a greater preference for low inflation than for getting rid of tax distortions (Gros, 1988).

There is a danger that, as Europe moves from the EMS towards the EMU, the German hegemony in monetary policy is weakened and consequently the discipline of the Bundesbank is diluted. Although the Delors Report envisages the EuroFed to be modelled on the Bundesbank and have an independent status, one may throw away the baby with the bath water: as central bankers of weaker members of the EMU get votes in the running of the EuroFed, the monetary discipline of the EMU may be weakened.

6 Private consumption and unemployment

So far, the analysis has stressed the effects of unanticipated inflation on wiping out the real value of debt service and of nominal government debt. The effects of unanticipated inflation on output and unemployment has received a lot of attention in the New Classical literature and in the literature on rules versus discretion (e.g. Barro and Gordon, 1983). Giavazzi and Pagano (1988) have applied this literature to explain that countries may wish to join the EMS and peg their currencies to the Deutschemark in order to enjoy

the excellent anti-inflation and discipline of the Bundesbank. The purpose of this section is to integrate this literature into a model of tax/seigniorage smoothing and to emphasise the merits of an independent EuroFed for the EMU.

6.1 Aggregate supply, unanticipated inflation and the tax wedge

Aggregate supply of goods is given by the following schedule:

$$\log(Q_i) = \log(\bar{Q}_i) - \phi_0 - \phi_1 \tau_i + \phi_2(\pi - \pi^e), \quad i = 1, \ldots, N, \tag{16}$$

where Q_i denotes the actual level of output, and $\bar{Q}_i$ denotes the full-employment level of output of country i. There is no labour mobility, so one can write the unemployment rate (u_i) as

$$u_i \equiv \left(\frac{\bar{Q}_i - Q_i}{\bar{Q}_i} \right) \cong \phi_0 + \phi_1 \tau_i - \phi_2(\pi - \pi^e), \quad i = 1, \ldots, N. \tag{16'}$$

An increase in the tax rate drives a wedge between the producers' and consumers' wage, hence reduces the incentive to work and produce. Consequently, aggregate supply falls and the rate of unemployment rises. Frictions in the labour market ($\phi_0 > 0$) also cause the equilibrium level of output to fall short of the full-employment level of output. Given absence of ex-ante indexation of wages, a surprise increase in inflation erodes the real value of the predetermined nominal wage and thus boosts employment and aggregate supply. Output is assumed to be perishable and cannot be used as capital for use in future production.

Aggregate demand for goods in country i consists of private consumption, C_i and government spending, G_i. Equilibrium in the goods markets can be written as [6]

[6] Strictly speaking, the difference between the left-hand and right-hand side of (17) equals the trade balance and the dynamics of the current account is given by

$$\dot{f}_i = r_i f_i + 1 - \phi_0 - \phi_1 \tau_i + \phi_2(\pi - \pi^e) - \kappa(\pi, \tau_i) - c_i - g_i, \quad i = 1, \ldots, N$$

$$Q_i - \kappa(\pi, \tau_i)\bar{Q}_i = C_i + G_i, \quad i = 1, \ldots, N \tag{17}$$

where $\kappa(\pi, \tau_i)$ denotes a strictly convex function capturing the reduction in production efficiency (or the dead-weight losses) arising from the extraction of non-monetary taxes and seigniorage revenues (cf. Obstfeld, 1990). It satisfies $\kappa(0,0) = \partial\kappa(0,0)/\partial\pi = \partial\kappa(0,0)/\partial\tau_i = 0$. Since the non-monetary tax system is not always indexed, π and τ_i may affect $\kappa(.)$ in a non-separable fashion. The loss in production efficiency is proportional to the full-employment level of output. Combining equations (16) and (17), one obtains the following expression for the full-employment national income shares of private consumption:

$$c_i \equiv \left(\frac{C_i}{\bar{Q}_i}\right) = 1 - \phi_0 - \phi_1\tau_i + \phi_2(\pi - \pi^e) - \kappa(\pi, \tau_i) - g_i, \tag{18}$$

where $g_i \equiv G_i/\bar{Q}_i, \quad i = 1, \ldots, N$.

The governments of the countries making up the monetary union choose their budgetary policies to finance their required levels of present and future exhaustive government spending and to maximise welfare functions of the form:

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where f_i denotes the ratio of net foreign assets to the full-employment level of output in country i. Since households use the current account to smooth private consumption, (18) should really be given by

$$c_i = r_i f_i + 1 - \phi_0 - \phi_1\tau_i^P + \phi_2(\pi^P - \pi^{eP}) - \kappa^P(\pi, \tau_i) - g_i^P, \quad i = 1, \ldots, N.$$

However, as the governments find it optimal to smooth tax and inflation rates, one has

$$c_i = r_i f_i + 1 - \phi_0 - \phi_1\tau_i + \phi_2(\pi - \pi^e) - \kappa(\pi, \tau_i) - g_i^P, \quad i = 1, \ldots, N$$

which reduces to (18) when one assumes that the national income shares of exhaustive government spending are constant and that initial holdings of foreign assets are zero.

$$\hat{W}_i \equiv \int_0^\infty \exp(-(\rho+n)t)[C_i(t) - \frac{1}{2}\psi u_i(t)^2 \bar{Q}_i(t)]dt, \quad i = 1,\ldots,N. \quad (19)$$

If the cost function $\kappa(.)$ is assumed to separable and quadratic, $\kappa(.) = \frac{1}{2}\kappa_1\tau_i^2 + \frac{1}{2}\kappa_2\pi^2$ and $\dot{\bar{Q}}_i/\bar{Q}_i = n, \quad i = 1,\ldots,N$, the reduced-form welfare functions can be written as:

$$\hat{W}_i = \int_0^\infty \exp(-\rho t)[1 - \phi_0 - \phi_1\tau_i(t) + \phi_2(\pi(t) - \pi^e(t)) - \frac{1}{2}\kappa_1\tau_i(t)^2$$

$$-\frac{1}{2}\kappa_2\pi(t)^2 - g_i(t) - \frac{1}{2}\psi u_i(t)^2]dt, \quad i = 1,\ldots,N. \quad (19')$$

The welfare-loss function (7), employed in Sections 2-5, is equivalent to the welfare function (19'), if one abstracts from the effects of the tax wedge and unanticipated inflation on aggregate supply ($\phi_1 = \phi_2 = 0$), ignores the effects of unemployment on welfare ($\psi = 0$), and defines $\beta \equiv \kappa_2/\kappa_1$. In general, social welfare corresponds to maximising the present value of private consumption minus the present value of costs associated with unemployment. Since unemployment is one of the main reasons for economic inequality, this seems the easiest way to allow for both efficiency and equity considerations. The costs of unemployment are quadratic in the unemployment rate and proportional to the full-employment level of output [7]. This quadratic term facilitates a comparison with the previous literature on unanticipated inflation and employment (Barro and Gordon, 1983).

There is an additional policy problem, because the presence of tax wedges and frictions in the labour market ($\phi_0 + \phi_1\tau_i$) implies that the equilibrium level of output is insufficient to employ all members of the labour force. The government is then tempted to use unanticipated inflation to fight unemployment. Such a policy must in the long run always be in vain, so that in rational-expectations equilibrium one must end up with higher inflation. A first-best policy is to eridicate the labour-market distortions directly, i.e. use structural labour-market policies to drive ϕ_0 down to zero, because then this motive for unanticipated inflation disappears. Such a first-best policy

[7] It is straightforward to allow for a linear term in unemployment, say $-\psi' u_i \bar{Q}_i$, because then effectively the ϕ_i are replaced by $\phi_i(1+\psi'), i = 0,1,2$. If one values leisure rather than penalises unemployment, ψ' is negative and the ϕ_i become smaller.

provides ammunition against the familiar positive theories of inflation (e.g. Barro and Gordon, 1983), because one can legitimately argue that structural labour-market policies are a much better response to fighting unemployment than unanticipated inflation. However, if one integrates the positive "screw-up" theories of inflation with the public-finance theories of tax/seigniorage smoothing, it is optimal to have some unemployment in equilibrium because distortionary taxes are required to finance a given stream of government spending. This means that, even if $\phi_0 = 0$, there is an incentive left for unanticipated inflation in the fight against unemployment as long as ϕ_1 is not zero.

6.2 Three motives for unanticipated inflation

In the present model there are thus three independent motives for unanticipated inflation: (i) to wipe out the real value of debt service (as discussed in Sections 4 and 5); (ii) to wipe out the real value of nominal wage contracts and thus fight unemployment; and (iii) to raise output and provide more resources for private consumption. The analysis of Sections 3-5 can be repeated for this more generalised model. In order not to go into unnecessary detail, attention is restricted to the cooperative outcomes under rules and discretion and to the outcome under an independent common central bank. The CR-outcome yields

$$\left(\frac{\beta\pi^{CR}}{m}\right) = \tau_i^{CR}(1+\psi\phi_1^2) + \phi_1(1+\psi\phi_0), \quad \dot{\tau}_i^{CR} = 0, \quad i = 1,\ldots,N, \quad (20)$$

so tax/seigniorage revenues are smoothed and go up and down together as usual. Comparing (20) with (9), it is clear that the marginal cost of taxation has gone up due to the adverse effects on aggregate supply and thus on private consumption and the rate of unemployment. This is why governments find it optimal to levy relatively more seigniorage revenues and less conventional tax revenues than before (cf. equation (11)):

$$\tau^{CR} = \left(\frac{\rho k - \phi_1(1+\psi_0)\left(\frac{m^2}{\beta}\right)}{1+\left(\frac{m^2}{\beta}\right)(1+\psi\phi_1^2)}\right). \quad (21)$$

where $k \equiv d + \left(\frac{g^P - nm}{\rho}\right)$ denotes the region's average level of government

commitments. It is easy to show that, if $\phi_1 = 0$, welfare under the optimal CR-outcome follows from:

$$\rho \hat{W}^{CR} = 1 - \phi_0 - \frac{1}{2}\psi\phi_0^2 - g^P - \frac{1}{2}\left(\frac{\beta}{\beta + m^2}\right)(\rho k)^2. \qquad (22)$$

Note that, as before, a high level of government commitments reduces welfare. Also, a high level of government spending reduces welfare directly, because it crowds out private consumption. A higher stock of real money balances, which is willingly held by private agents, give rise to more seigniorage revenues and thus requires less tax distortions and boosts welfare. The presence of frictions on the labour market (ϕ_0) reduces output and thus leaves less room for private consumption and increases unemployment, so reduces welfare.

If the governments do not have the trust of private agents, the discretion outcome is appropriate:

$$\left(\frac{\left(\frac{\beta\pi^{CD}}{m}\right) - \left(\frac{\phi_2}{m}\right)(1 + \psi u_i)}{1 + (d_i/m)}\right) = \tau^{CD}(1 + \psi\phi_1^2) + \phi_1(1 + \psi\phi_0) \qquad (20')$$

Comparing (20') with (20), one notices three additional effects in the left-hand side of (20'). Each one of them depresses the marginal cost of inflation and in equilibrium leads to a higher rate of inflation. They correspond to the three motives for unanticipated inflation discussed above. Non-monetary tax rates and monetary growth rates go up and down together as usual, but under discretion an increase in the tax rate must go up with a more than equiproportionate increase in monetary growth. Combined with the fixed bias towards using monetary growth, it is clear that in Figure 1 the locus describing (20') is steeper than the one describing (20) and also that (20') cuts the vertical axis above (20). Intersection with the present-value government budget constraint $(GBC), t + \theta m = \rho k$, yields the optimal government revenue mix.

Insert Figure 1: Effects of higher government commitments under rules and discretion.

Discretion yields higher monetary growth, inflation and nominal interest

rates and consequently lower tax rates than rules. A permanent increase in government commitments shifts out the GBC-locus and leads to higher tax rates and higher monetary growth, but under discretion there is **relatively** a greater increase in seigniorage revenues. Algebraically, one finds:

$$\tau^{CD} = \left(\frac{\rho k - (1 + \psi\phi_0)\left(\frac{m}{\beta}\right)[\phi_1(m+d) + \phi_2]}{1 + \left(\frac{m(m+d)}{\beta}\right)(1 + \psi\phi_1^2) + \left(\frac{m}{\beta}\right)\phi_1\phi_2\psi} \right) < \tau^{CR} \qquad (21')$$

and thus $\pi^{CD} > \pi^{CR}$. Upon substitution of (20') and (21'), one finds (for $\phi_1 = 0$) the corresponding level of welfare:

$$\rho\hat{W}^{CD} = 1 - \phi_0 - \frac{1}{2}\psi\phi_0^2 - g^P$$

$$-\frac{1}{2}\left(\frac{\left[1 + \left(\frac{(m+d)^2}{\beta}\right)\right](\rho k)^2 + 2\rho\left(\frac{\phi_2}{\beta}\right)(1 + \psi\phi_0)dk + \left(\frac{\phi_2^2}{\beta}\right)(1 + \psi\phi_0)^2\left[1 + \left(\frac{m^2}{\beta}\right)\right]}{\left[1 + \left(\frac{m(m+d)}{\beta}\right)\right]^2} \right)$$

$$< \rho\hat{W}^{CR}. \qquad (22')$$

Welfare is lower under discretion than under rules because there are two good reasons why lack of credibility forces governments to rely on a sub-optimal revenue mix: (i) outstanding stocks of nominal government debt ($d > 0$); (ii) predetermined nominal wage contracts ($\phi_2 > 0$). The second reason gives rise to an incentive to use unanticipated inflation to boost private consumption **and** to cut unemployment. The presence of structural labour-market imperfections ($\phi_0 > 0$) reinforces these reasons for unanticipated inflation and depresses welfare under discretion even more. Since unanticipated inflation affects unemployment and private consumption, discretion yields higher inflation than rules even when all government bonds are indexed.

6.3 The case for an independent common central bank revisited

If there is an independent common central bank whose sole task it is to maintain price stability, seigniorage occurs only through real growth and one has $\pi^I = 0$, $t^I = \rho k > t^{CR} > t^{CD}$ and

$$\rho\hat{W}^I = 1 - \phi_0 - \frac{1}{2}\psi\phi_0^2 - g^{I'} - \frac{1}{2}(\rho k)^2 < \rho\hat{W}^{CR}. \qquad (23)$$

Since an independent central bank clearly has a sub-optimal revenue mix, it leads to lower welfare than a cooperative monetary union with a sound monetary discipline. However, a more relevant comparison is with a cooperative monetary union with a dependent central banking system which does not have the benefit of sound monetary discipline. In that case a second-best institutional set-up, such as an independent common central bank, may well be preferable. In fact, if $\phi_1 = \phi_2 = 0$, this is the case when (14) is satisfied. Clearly, an autonomous central bank is preferred when the production losses arising from conventional taxes are much less than those arising from inflation (e.g. when there is no substantial underground economy) and when the outstanding stock of nominal government debt is high.

In the extreme case that there are no production losses or adverse supply effects from taxation ($\phi_1 = \kappa_1 = 0$), one **always** prefers an independent central bank even if one allows for the effects of unanticipated inflation on aggregate supply ($\phi_2 > 0$):

$$\rho\hat{W}^I - \rho\hat{W}^{CD} = \rho\hat{W}^{CR} - \rho\hat{W}^{CD} = \frac{1}{2}\left(\frac{\phi_2^2}{\kappa_2}\right)(1+\psi\phi_0)^2 > 0. \qquad (14')$$

The point is that the presence of predetermined nominal wage contracts provides an incentive to use a surprise inflation tax for a boost to employment and private consumption, so that in the absence of an autonomous monetary authority inflation must in equilibrium be higher and taxes must be lower ($\pi^{CD} = \left(\frac{\phi_2}{\kappa_2}\right)(1+\psi\phi_0) > \pi^I = 0, \tau^{CD} = \rho k - \left(\frac{\phi_2}{\kappa_2}\right)(1+\psi\phi_0) < \tau^I = \rho k$). Since there are no production losses arising from non-monetary taxes, one always prefers an independent central bank. Note that, in contrast to Barro and Gordon (1983), the present argument does not require the presence of frictions in the labour market for a positive explanation of inflation.

If there are no production losses from taxation and the government does not have unemployment as an explicit target ($\kappa_1 = \psi = 0$) but the tax wedge and unanticipated inflation do affect output and private consumption ($\phi_1, \phi_2 > 0$), one also has excessive inflation ($\pi^{CD} = [\phi_1(m+d)+\phi_2]/\kappa_2 > 0$) and a lower tax rate ($\tau^{CD} = \rho k - m\pi^{CD} < \tau^I$). It is straightforward to

show that, when the effects of unanticipated inflation are much larger than the effects of the tax wedge on aggregate supply and when the outstanding stock of nominal government is high, i.e. when the inequality

$$\phi_1 d + \phi_2 > \phi_1 m \tag{14''}$$

is satisfied, one prefers an independent common central bank to a cooperative monetary union with a dependent central banking system.

7 Expected inflation and the demand for money

The problems of time inconsistency which arose in Sections 2-6 can be avoided if governments issue real or indexed bonds and wage contracts contain indexation clauses. However, the analysis in these sections has adopted the quantity theory of money and thus assumed that the velocity of circulation in each country is constant. It is more realistic to assume that the demand for money in each country is a negative function of the nominal interest rate:

$$m = \Gamma(\pi^e) = \gamma_0 \exp[-\gamma_1(\rho + \pi^e)], \quad \Gamma' \leq 0, \tag{24}$$

where γ denotes the semi-elasticity of money demand with respect to the nominal interest rate. Note that this formulation of money demand implies a unit income elasticity and no wealth effects. This formulation allows for time inconsistency problems, even now it is assumed that governments issue debt with a guaranteed real rate of return ($r_i \equiv \rho$) and wage contracts are indexed ($\phi_2 = 0$). For simplicity, the effects of the tax wedge on aggregate supply are ignored from now on ($\phi_1 = 0$) so that aggregate supply and the rate of unemployment are exogenous. It is clear that, maximising (19) or (19') is then equivalent to minimising the welfare loss (7) and that the three motives for unanticipated inflation discussed in Section 6 disappear.

However, governments now have an incentive to use an unanticipated increase in the price level as this wipes out the real value of money holding at the "stroke of a pen". This classical problem arises because money does not bear a rate of return: "An issue of notes is a manifest gain to the issuers, who, until the notes are returned for payment, obtain the use of them as if

they were a real capital ... all holders of currency lose, by the depreciation of its value, the exact equivalent of what the issuer gains" (Mill, 1848, Book 3, Chapter 8, Section 4) and "The burden of the (inflation) tax is well spread, cannot be evaded, costs nothing to collect, and falls, in a rough sort of way, in proportion to the wealth of the victim. No wonder its superficial advantages have attracted Ministers of finance ... it seems possible to please and content the public, for a time at least, by giving them, in return for taxes they pay, finely engraved acknowledgements on watermarked paper ... The higher the toll and the tax, the less traffic on the roads, and the less business transacted, so also the less money carried" (Keynes, 1923, pp. 39, 43, 53). It is clear from these two quotes that the demand for money should depend on the opportunity cost of holding money. The use of capital levies versus the use of currency depreciation were discussed by Keynes in great detail. In modern theories of public finance, one wonders why people hold money in the first place when it is clear that they cannot necessarily trust governments not to impose a capital levy of this type.

Instead of equation (4), equation (24) implies

$$\dot{\pi}^e(t) = \left(\frac{1}{\gamma_1}\right)[\pi(t) + n - \theta(t)] \tag{4'}$$

which upon integration yields

$$\pi(t) = \left(\frac{1}{\gamma_1}\right)\int_t^\infty \exp\left[-\left(\frac{v-t}{\gamma_1}\right)\right]\theta^e(v,t)dv - n \tag{4''}$$

where $\theta^e(v,t)$ denotes the expectation of $\theta(v)$ held at time t. The rate of inflation now depends on expectations about future monetary growth, hence both π and m should now be treated as non-predetermined, forward-looking variables. The rules outcome is obtained by minimising the welfare loss function (7) subject to equations (1'), (3) and (4') under the assumption that $\pi^e = \pi$. It is a straightforward exercise to show that this yields

$$[1 - \gamma_1(\rho + \pi^{NR} + n)]\tau_i^{NR} = \left(\frac{\beta\pi^{NR}}{N\Gamma(\pi^{NR})}\right), \quad \dot{\tau}_i^{NR} = 0, \quad i = 1, \ldots, N \tag{25}$$

for the non-cooperative outcome, and

$$[1-\gamma_1(\rho+\pi^{CR}+n)]\tau_i^{CR}=\left(\frac{\beta\pi^{CR}}{\Gamma(\pi^{CR})}\right), \quad \dot{\tau}_i^{CR}=0, \quad i=1,\ldots,N \qquad (26)$$

for the cooperative outcome. Discretion implies that governments have insufficient credibility to influence expectations, so governments minimise their welfare losses taking the expected inflation rate as given [8]. This yields

$$\tau_i^{ND}=\frac{\beta\pi^{ND}}{N\Gamma(\pi^{ND})}, \quad \dot{\tau}_i^{ND}=0, \quad i=1,\ldots,N \qquad (25')$$

for the non-cooperative outcome, and

$$\tau_i^{CD}=\frac{\beta\pi^{CD}}{\Gamma(\pi^{CD})}, \quad \dot{\tau}_i^{CD}=0, \quad i=1,\ldots,N \qquad (26')$$

for the cooperative outcome. The departure from the quantity theory of money, followed in this section, implies that in each of the four outcomes the optimal inflation rate is lower and the optimal tax rate is higher than before, because governments now take account of citizens economising on holdings of money when the monetary growth and inflation increase. The insight that absence of international policy coordination induces central banks to appropriate too much seigniorage revenues and thus leads to too high inflation rates and to too low tax rates ($\pi^{CD}<\pi^{ND}, \pi^{CR}<\pi^{NR}$) remains unaltered. The main additional insight is that competitive decision making leads to an erosion of the base for raising seigniorage revenues [9], so that tax rates do not fall as much as they would otherwise.

More interesting is perhaps that one can show that absence of monetary discipline reduces the costs of higher inflation, as governments realise they are unable to influence expectations and thus unable to affect the demand

[8] In fact, this implies somewhat naive behaviour of private agents because they might use the level of outstanding government commitments to forecast inflation and the government should in a dynamic environment take such a forecast function rather than the expected rate of inflation as given. Section 8 explores these issues in more detail.

[9] In fact, Aizenman (1989), who does not address the issue of monetary discipline, argues that this erosion of the inflation-tax base may even put the monetary union on the wrong side of the seigniorage-Laffer curve.

for money and the base for raising seigniorage revenues, and thus leads in equilibrium to higher inflation and lower tax rates ($\pi^{CD} > \pi^{CR}, \pi^{ND} > \pi^{NR}$). Although it is a bit more messy, the analysis of Section 5 can be repeated to show that it is desirable to have an independent common central bank when the benefits of lower inflation and enhanced discipline outweigh the disadvantages of more tax distortions. It is straightforward to show that the stronger the effect of nominal interest rates and expected inflation on money demand, the stronger the case for an independent central bank.

The above results may not be robust to the specification of money demand. For example, if there are only two assets, viz. money and bonds, and the portfolio shares $(m_i/(m_i + d_i))$ depend only on the relative return of these two assets, i.e. expected inflation, the optimal steady-state inflation rate for a closed-economy (and thus for a cooperative monetary union) is determined by the full liquidity rule in the sense that nominal interest rates are driven to zero (Turnovsky and Brock, 1980; Yashiv, 1989). In that case inflation and tax rates do not go up and down together anymore and there is no permanent need for international policy coordination in a monetary union without an independent central bank. The results thus depend heavily on the exact specification of the effect of expected inflation on the demand for money. It therefore seems worthwile to proceed with a properly specified model of the ongoing strategic interactions between governments and private agents.

8 Micro foundations of monetary policy games

The analysis of Sections 2-7 did not benefit from a fully specified model of monetary policy games with micro foundations. There is a danger that some of the results do not carry over to a fully specified model of the ongoing strategic interactions between optimising governments and a rational private sector in which one distinguishes between pre-commitment and Markov-perfect equilibria. Calvo (1978) has already shown that discretion, i.e. lack of pre-commitment, in the face of the temptation to tax cash money balances through unanticipated inflation induces higher inflation than under rules, whereas the tax/seigniorage smoothing literature argues that inflation, whatever its current level, is persistent. In a very interesting paper Obstfeld (1991b) shows that, when one restricts attention to Markov-perfect equilibria in which governments cannot commit to pre-announced monetary policies, the familiar result from public finance that it is optimal

to smooth seigniorage revenues and inflation rates no longer holds. Instead, Obstfeld argues that under discretion the optimal inflation rate falls over a time towards the socially preferred full liquidity rule. Hence, a permanent increase in government spending induces a temporary bout in inflation and seigniorage revenues which permits the government to retire debt, reduce the burden of debt service and make room for the higher level of spending. This is in sharp contrast to the Ramsey principle of optimal taxation, stressed by the tax/seigniorage smoothing approach, which argues that both the tax rate and the inflation rate jump upwards and stay at the higher levels in response to a permanent increase in government spending. Obstfeld presented his analysis in discrete time, which allows a careful specification of the sequence of moves in the dynamic game. Here the analysis is conducted in continuous time and applied within the context of a monetary union.

8.1 Markov-perfect equilibrium

Assume that the labour market functions perfectly, that debt and wage contracts are indexed to the price level and that there is no real growth ($r_i = \rho, \quad \phi_1 = \phi_2 = n = 0$). The representative household in country i maximises its utility function,

$$U_i(t) \equiv \int_t^{\infty} \exp[-\rho(v-t)][c_i(v) + \Omega(m_i(v))]dv, \tag{27}$$

subject to its budget constraint,

$$\dot{a}_i = \rho a_i + 1 - \phi_0 - \kappa(\pi, \tau_i) - c_i - \tau_i - (\rho + \pi^e)m_i, \tag{28}$$

where a_i denotes the ratio of private asset holdings to income in country i, $\quad i = 1, \ldots, N$. Households take the tax and inflation rates as given. The linearity of utility in consumption fixes the equilibrium real interest rate at the pure rate of time preference (ρ). The function $\Omega(.)$ captures the transactions services from holding real money balances and is twice continuously differentiable, increasing and strictly concave for positive m. Alternatively, low levels of money demand associated with high inflation induce "shoe-leather" welfare costs. Households set the marginal utility

equal to the opportunity cost of holding real money balances, i.e. $\Omega'(m_i) = \rho + \pi^e$. This yields the money demand function $m = \Gamma(\pi^e), \Gamma' \leq 0$. For example, if $\Omega(m) = \left(\frac{m}{\gamma_1}\right)[\log(\gamma_0) + 1 - \log(m)]$ with $m < \gamma_0$, one obtains equation (24) with a constant semi-elasticity of money demand with respect to the nominal interest rate.

Households predict the inflation rate using information on the average outstanding level of government commitments:

$$\pi^e = F(k), \quad m = \Gamma(F(k)) \equiv M(k), \quad F' \geq 0, \quad M' = \Gamma' F' \leq 0 \qquad (29)$$

where $F(.)$ denotes the forecast function. The intuition is that, when the level of commitments is high, the central bank requires more seigniorage revenues and consequently private agents forecast a higher inflation rate and hold less money balances. The equilibrium satisfies the Markov property, because households only use present and not past levels of government commitments to forecast inflation (cf. Fudenberg and Tirole, 1986). An important assumption underlying the present analysis is that private agents do not use information on the current tax rate and current rate of monetary growth in making their forecast of inflation. In this sense, the government has lost most of its leadership role. This seems reasonable in a continuous-time analysis of credible policies.

The household budget constraint, (28), is implied by the condition for equilibrium in the goods market, (18), the condition for equilibrium in the money market, $\dot{m} = (\theta - \pi)m$, the condition for equilibrium in the bonds market, $a - m = d$, and the government budget constraint, (1) or, alternatively, $\dot{k} = \rho k - \tau - \theta m$.

As in Section 7, attention is restricted to a cooperative monetary union so that effectively there is one government which maximises the region's welfare function. If $V(k)$ denotes the value function of the regional government, it is clear that the optimal policy for the region follows from the Bellman equation of dynamic programming [10]:

$$\rho V(k) = \underset{\tau_i,\theta}{\text{Max}} \left(\sum_{i=1}^{N} \left\{ 1 - \phi_0 - \frac{1}{2}\kappa_1 \tau_i^2 - \frac{1}{2}\kappa_2 \left[\theta - \left(\frac{M'(k)}{M(k)} \right) (\rho k - \tau - \theta M(k)) \right]^2 - g_i \right\} \right.$$

[10] For simplicity, attention is restricted to stationary Markov-perfect equilibria so that time is omitted as an argument.

$$+N\Omega(M(k)) + NV'(k)\left[\rho k - \tau - \theta M(k)\right]\Big]. \tag{30}$$

This yields the following first-order conditions:

$$\tau_i = \left(\frac{\kappa_2 \pi}{M(k)\kappa_1}\right) = \tau, \quad i = 1, \ldots, N \tag{31}$$

$$\kappa_2 \pi[1 + M'(k)] = -V'(k)M(k) \tag{32}$$

where the rate of inflation is given by

$$\pi = \theta[1 + M'(k)] - \left(\frac{M'(k)}{M(k)}\right)(\rho k - \tau). \tag{33}$$

Equation (31) is the familiar condition which says that intratemporal marginal distortions from the various sources of raising revenues must be equalised, i.e. for a given level of government commitments the optimal tax rate and the optimal inflation rate must go up and down together. However, if the level of government commitments is high, expected inflation is high and consequently the ratio of money balances to income is low and the ratio of the optimal tax rate to the optimal inflation rate is high. Equations (31)-(33) can be solved to give $\tau_i = T(k)$, $i = 1, \ldots, N$, $\pi = \Pi(k)$ and $\theta = \Theta(k)$. Rational expectations requires that forecasts of private agents are correct:

$$\pi^e = F(k) = \Pi(k). \tag{34}$$

The resulting equilibrium must ensure that private agents accurately forecast government policies in equilibrium, that the markets for goods, money and bonds clear, that the present-value budget constraints of private agents and of governments are satisfied, and that the government policy rules for the tax rate and rate of monetary growth for a given level of commitments take account of the behaviour of aggregate money demand induced by private decision rules. More formally, the equilibrium consists of a forecast schedule for inflation, $F(k)$, an aggregate demand schedule for real money balances, $M(k)$, a monetary growth rule, $\Theta(k)$, a tax rule, $T(k)$, and a rule

for inflation, $\Pi(k)$, such that: (i) $\theta = \Theta(k)$ and $\tau = T(k)$ maximise social welfare subject to the government budget constraint for all t and all possible $k(0)$ given $m = M(k)$; (ii) $m = M(k)$ maximises household utility for all t and all possible $k(0)$ given $\pi^e = F(k)$; and (iii) $\pi = \Pi(k)$ is calculated from (33) given $\theta = \Theta(k), \tau = T(k)$ and $m = M(k)$, and must equal $F(k)$ for all k. An attractive property of the feedback policy rules thus obtained is that they are optimal and credible even when the economy deviates from the equilibrium path.

8.2 Temporary bouts of inflation and taxation

Following Obstfeld (1991b), it seems worthwhile to construct a simple linear example which drops $\Omega(m)$ from the social welfare function and replaces the production-losses function $\kappa(\pi, \tau)$ by $\kappa(\bar{\pi}, \tau)$, where inflation-tax payments are defined as $\bar{\pi} \equiv \pi m$. In addition, the utility households derive from holding real money balances is given by $\Omega(m) = \gamma[m_F \log(m) - m]$ where m_F denotes Friedman's optimum quantity of money as $\Omega'(m_F) = 0$ (cf. van der Ploeg, 1988). For simplicity, only one country is considered.

A linear aggregate money demand schedule, $M(k) = \mu_0 - \mu_1 k$, where μ_0, $\mu_1 > 0$, is postulated, so that inflation-tax payments can with the aid of the government budget constraint be written as

$$\bar{\pi} = \bar{\theta} - \dot{m} = (1 - \mu_1)\bar{\theta} + \mu_1(\rho k - \tau). \tag{33'}$$

Performing the maximisation in the Bellman equation with respect to τ and $\bar{\theta}$ yields $\kappa_1 \tau = \kappa_2 \bar{\pi} = -\left(\frac{V'(k)}{1-\mu_1}\right)$ (cf. equations (31)-(32)). Postulate a quadratic value function, $V(k) = v_0 + v_1 k - \frac{1}{2} v_2 k^2$, and substitute this together with the optimal rules for τ and $\bar{\pi}$ into the Bellman equation:

$$\rho(v_0 + v_1 k - \frac{1}{2} v_2 k^2) = 1 - \phi_0 - g + \frac{1}{2}\left(\frac{1}{\kappa_1} + \frac{1}{\kappa_2}\right)\left(\frac{v_1 - v_2 k}{1 - \mu_1}\right)^2 + \left(\frac{\rho}{1 - \mu_1}\right)(v_1 - v_2 k)k. \tag{30'}$$

The Bellman equation must hold for all values of k, so equating coefficients on k and k^2 yields $v_1 = 0$ and $v_2 = \left(\frac{\rho(1-\mu_1^2)}{\frac{1}{\kappa_1} + \frac{1}{\kappa_2}}\right)$. It follows that $\left(\frac{\tau}{\beta}\right) = \bar{\pi} = \left(\frac{1+\mu_1}{1+\beta}\right)\rho k \equiv F(k)$ where $\beta \equiv \kappa_2/\kappa_1$.

Households maximise utility and set the marginal utility equal to the opportunity cost of holding money balances, so $m = \left(\frac{\gamma m_F - \bar{\pi}^e}{\rho+\gamma}\right)$. Rational expectations requires that $\bar{\pi}^e = F(k)$, so that in equilibrium

$$m = \left(\frac{\gamma m_F - \left(\frac{1+\mu_1}{1+\beta}\right)\rho k}{\rho+\gamma}\right) = M(k) = \mu_0 - \mu_1 k \qquad (34')$$

must hold for all k. Hence, $\mu_0 = \left(\frac{\gamma}{\rho+\gamma}\right) m_F$ and $\mu_1 = \rho/[(\rho+\gamma)\beta+\gamma]$ so that the optimal tax rate and level of inflation-tax payments must satisfy:

$$\frac{\tau^M}{\beta} = \bar{\pi}^M = \left(\frac{\rho+\gamma}{(\rho+\gamma)\beta+\gamma}\right)\rho k \qquad (35)$$

where the superscript M denotes Markov-perfect equilibrium. It also follows from the government budget constraint that

$$\dot{k}^M = -\eta k, \quad \eta \equiv \left(\frac{\rho^2}{\gamma(\beta+1)+\rho(\beta-1)}\right), \quad k(0) = k_0 \qquad (36)$$

A characterisation of this Markov-perfect equilibrium is now possible. In steady state the government does not levy taxes or extract inflation-tax payments from the private sector ($\tau(\infty) = \bar{\pi}(\infty) = 0$). Instead, the government builds up assets to generate just enough interest payments to finance the permanent level of government spending ($k(\infty) = 0$). The steady-state stock of real money balances lies below Friedman's optimum quantity of money $\left(m(\infty) = \left(\frac{\gamma}{\rho+\gamma}\right) m_F < m_F\right)$. The policy of retiring government debt and building up assets equal to the present value of future government spending ensures that in steady state there is no need to supplement the budget and consequently there are no production efficiency losses arising from taxation or inflation.

To understand the dynamics of the equilibrium, consider a permanent increase in government spending ($k(0)$ jumps from zero to a positive amount). It follows that inflation-tax payments and the tax rate jump up immediately to a higher level than is required to finance the increase in government spending with a balanced budget. The additional revenues are used to build up assets. As this is done, taxes and inflation-tax payments fall and eventually disappear when enough assets have been built up to finance the increase in government spending.

8.3 Comparison with pre-commitment equilbrium

The pre-commitment or rules outcome is derived in the usual fashion:

$$\left(\frac{\gamma}{\rho+\gamma}\right)\left(\frac{\tau^R}{\beta}\right) = \bar{\pi}^R = \bar{\theta}^R = \left(\frac{\gamma}{(\rho+\gamma)\beta+\gamma}\right)\rho k < \bar{\pi}^M, \qquad (35')$$

so that it relies relatively more on non-monetary taxes than inflation-tax payments, and also gives rise to the familiar random walk property of taxes and inflation-tax payments, $\dot{\tau}^R = \dot{\bar{\pi}}^R = \dot{k}^R = 0$. A consequence is that in the pre-commitment equilibrium the government only borrows for temporary increases in spending $\dot{d}^R = g - g^P$. Note that, for a given level of government commitments, the tax rate is the same in the pre-commitment and in the no-commitment equilibrium, $\tau^M = \tau^R$ for a given k.

Insert Figure 2: Temporary bouts of inflation and taxation

Figure 2 compares what happens under the Markov-perfect equilibrium story and the traditional tax/seigniorage smoothing story. Note that tax/-seigniorage smoothing occurs as a degenerate special case of the Markov-perfect equilibrium when money demand does not depend on expected inflation ($\gamma \to \infty, m = m_F$), because then $\dot{k} = \dot{\tau} = \dot{\bar{\pi}} = 0$. In general, taxes and seigniorage do not follow random walks if private agents use the level of outstanding government commitments to forecast inflation.

It is of some interest to consider the finance of a government investment project with a market rate of term. Since this does not affect the permanent level of government spending (inclusive of the return on investment projects), the tax/seigniorage smoothing story suggests that tax and inflation rates are unaffected and that the investment is financed through an increase in government debt. The Markov-perfect equilibrium suggests that, during the initial phase in which investment without a return takes place, tax and inflation-tax payments rise but during the phase in which there is a positive return on the project, they fall back to their non-distortionary levels [11]. During the initial phase government debt rises; afterwards government debt falls. Government debt does not return to its initial level, because the return on the project reduces commitments and permits a reduction in debt service.

[11] This could also explain the disinflation that occurred at the end of the Napoleonic and civil wars and World War I.

8.4 Comparison with independent central bank

An independent central bank is staffed by ultra-conservative central bankers who guarantee price stability, hence $\bar{\pi}^I = 0$, $\tau^I = \rho k$ and $\dot{d}^I = g - g^P$. One way of thinking about it is that the management of an independent central bank has an infinite aversion to inflation ($\beta \to \infty$) in which case the pre-commitment outcome converges to the outcome under an independent central bank ($\bar{\pi}^R \to \bar{\pi}^I = 0$ as $\beta \to \infty$). For a given value of k, it is easy to see that $\tau^I > \tau^R = \tau^M$ and $\bar{\pi}^M > \bar{\pi}^R > \bar{\pi}^I = 0$ must hold.

In order to asses the case for an independent central bank, consider the effects on social welfare of a permanent increase in government spending, Δg. Since $k(0) = \Delta g/\rho$, one has $\Delta V^I = -\left(\frac{1}{\rho}\right)[\Delta g + \frac{1}{2}\kappa_1 \Delta g^2]$ and

$$\Delta V^M = -\left(\frac{\Delta g}{\rho}\right) - \frac{1}{2}\kappa_1 \int_0^\infty \exp(-\rho t)\beta(\beta+1)\left[\frac{\rho+\gamma}{(\rho+\gamma)\beta+\gamma}\right]^2 \exp(-2\eta t)\Delta g^2 dt$$

$$= -\left(\frac{\Delta g}{\rho}\right) - \frac{1}{2}\kappa_1 \left(\frac{\beta(\beta+1)}{\rho+2\eta}\right)\left[\frac{\rho+\gamma}{(\rho+\gamma)\beta+\gamma}\right]^2 \Delta g^2. \qquad (37)$$

If the quantity theory of money holds ($\gamma \to \infty$), $\eta = 0$ so that the Markov-perfect equilibrium and the pre-commitment outcomes coincide and give a higher level of social welfare than under an independent central bank ($\Delta V^M = \Delta V^R > \Delta V^I$ as long as $\beta > 0$). If the undergrond economy and costs of tax collection are neglible ($\beta \to \infty$), $\eta = 0$ so that the Markov-perfect equilibrium and the pre-commitment outcomes coincide and correspond to the outcome under an independent central bank ($\Delta V^M = \Delta V^R = \Delta V^I$ if $\beta \to \infty$). In general, it is easy to show that $\Delta V^M > \Delta V^I$ for all finite $\beta \geq 0$ and $\gamma \geq 0$, so that no case be made for an independent central bank.

8.5 Correction: full liquidity and Friedman's OQM

Fundamental problems with the approach adopted so far are that, following Obstfeld (1991b), "menu costs" in the social welfare function are ignored whilst such costs do appear in the household utility function and that, also following Obstfeld (1991b), the non-distortionary inflation rate is chosen to be zero. This leads to the anomaly that the steady state of the Markov-perfect equilibrium is characterised by zero tax distortions, but not by full liquidity and Friedman's optimum quantity of money. To correct for this

anomaly without foresaking the advantages of a linear example, $\Omega(m)$ from the household utility function is for purposes of the social welfare function approximated by a second-order Taylor-series expansion around a steady state characterised by full liquidity ($\pi(\infty) = -\rho$) and Friedman's OQM ($m(\infty) = m_F$), i.e.

$$\Omega(m) = \gamma[m_F \log(m) - m] \cong \gamma\left[m_F \log(m_F) - m_F - \frac{1}{2}\left(\frac{(m_F - m)^2}{m_F}\right)\right], \quad (38)$$

and $\kappa(\bar{\pi}, \tau)$ is replaced by $\kappa(\bar{\pi} + \rho m_F, \tau)$.

Performing the maximisation in the Bellman equation yields $\kappa_1 \tau = \kappa_2(\bar{\pi} + \rho m_F) = -\left(\frac{V'(k)}{1-\mu_1}\right)$, which upon substitution and equating coefficients yields $\bar{\pi}^e = F(k)$ in terms of μ_0 and μ_1. Rational expectations, i.e. $M(k) = \left(\frac{\gamma m_F - F(k)}{\rho+\gamma}\right)$ must hold for all k, then gives $\mu_0 = (1-\mu_1)m_F$ and $\mu_1 = \left(\frac{\rho}{(\rho+\gamma)\beta+\gamma-\left(\frac{\gamma}{\rho+\gamma}\right)\left(\frac{1}{\kappa_2 m_F}\right)}\right)$. It follows that

$$\frac{\tau^M}{\beta} = \bar{\pi}^M + \rho m_F = \left(\frac{\rho+\gamma}{(\rho+\gamma)\beta+\gamma-\left(\frac{\gamma}{\rho+\gamma}\right)\left(\frac{1}{\kappa_2 m_F}\right)}\right)\rho(k+m_F) \quad (35'')$$

and

$$\dot{k}^M = -\eta(k+m_F), \quad \eta \equiv \left[\frac{[\rho + \left(\frac{\gamma}{\rho+\gamma}\right)\left(\frac{1}{\kappa_2 m_F}\right)]\rho}{\gamma(\beta+1) + \rho(\beta-1) - \left(\frac{\gamma}{\rho+\gamma}\right)\left(\frac{1}{\kappa_2 m_F}\right)}\right], \quad k(0) = k_0. \quad (36')$$

In steady state nominal interest rates are driven to zero, so monetary growth and inflation tend towards minus the pure rate of time preference, holdings of real money balances are pushed up towards Friedman's OQM, and tax rates are cut to zero. Hence, the steady state of this Markov-perfect equilibrium is characterised by no distortions whatsoever. This is achieved through the government building up assets equal to the sum of the present value of future government spending and Friedman's OQM, i.e. $k = -m_F$.

A permanent increase in government spending is financed through temporary bouts of taxation and inflation and leads to the following change in welfare:

$$\Delta V^M = -\left(\frac{\Delta g}{\rho}\right) - \frac{1}{2}\kappa_1 \left(\frac{\beta(\beta+1)}{\rho+2\eta}\right) \left[\frac{\rho+\gamma}{(\rho+\gamma)\beta+\gamma-\left(\frac{\gamma}{\rho+\gamma}\right)\left(\frac{1}{\kappa_2 m_F}\right)}\right]^2 \Delta g^2. \tag{37'}$$

The presence of an independent central bank guarantees full liquidity and Friedman's OQM, $\pi^I = \theta^I = -\rho, m^I = m_F$, so that $\tau^I = \rho(k+m_F), \dot{d}^I = g - g^P$ and $\Delta V^I = -\left(\frac{1}{\rho}\right)[\Delta g + \frac{1}{2}\kappa_1 \Delta g^2]$. It follows that a case can be made for an independent central bank only if

$$\left(\frac{\beta(\beta+1)\rho}{\rho+2\eta}\right) \left[\frac{\rho+\gamma}{(\rho+\gamma)\beta+\gamma-\left(\frac{\gamma}{\rho+\gamma}\right)\left(\frac{1}{\kappa_2 m_F}\right)}\right]^2 > 1. \tag{39}$$

Note that, when the production losses arising from inflation dominate menu costs ($\kappa_2 m_F \to \infty$), when the pure rate of time preference becomes large ($\rho \to \infty$) or when menu costs become insignificant ($\gamma \to 0$), the left-hand side of (39) tends to $\left(\frac{\beta-1}{\beta}\right)$ so that (39) is always violated and no case for an independent central bank can be made (cf. Section 8.4). Also, as money demand becomes inelastic ($\gamma \to \infty), \eta \to 0$, the left-hand side of (39) tends to $\left(\frac{\beta}{\beta+1}\right)$ and thus no case for an independent central bank can be made either. In fact, (39) is for all reasonable values of $\rho, \beta, \gamma, \kappa_2$ and m_F violated. Hence, given that all contracts are indexed, no case can be made for an independent central bank.

9 Concluding remarks

A monetary union without an independent common central bank leads, without coordination of the policies of the national fiscal and monetary authorities, to excessive inflation and to too low tax rates throughout the region. The reason is that each treasury fails to internalise the adverse external effects of appropriating more seigniorage revenues on the common inflation rate. An independent common central bank is inefficient from a public-finance point of view, since it gives rise to too low inflation rates and thus to too high tax rates. Nevertheless, an independent common central bank

may be desirable because it is more likely to have a strong monetary discipline and not to succomb to pressures of the national ministers of finance and trade unions to accommodate their demands with an unanticipated inflation tax. To assess the case for an independent common central bank such as the EuroFed, one should trade-off the welfare gains associated with enhanced monetary discipline and lower inflation against the welfare losses associated with a sub-optimal government revenue mix. When the stock of outstanding nominal government debt is high, when the priority that governments attach to price stability is much higher than to cutting tax distortions, when the size of the underground economy is insignificant and when there is not much wage indexation, one is much more likely to come out in favour of an independent common central bank for a monetary union.

Most of the analysis takes account of three independent motives for unanticipated inflation: (i) to wipe out the real value of debt service, (ii) to wipe out the real value of predetermined nominal wage contracts and thus boost employment, and (iii) to raise output and provide more resources for private consumption. If any of these motives are important, a strong case for an independent central bank can be made. However, if one takes account of the effect of expected inflation on the demand for money and assumes that private agents do not use information on the level of outstanding government commitments to forecast inflation, governments have an incentive to wipe out the real value of money holdings so discretion leads to higher inflation than rules. Also, absence of international policy cooperation induces higher inflation and to an erosion of the base for raising seigniorage revenues so tax rates fall by less as they would otherwise.

Matters become rather more exciting when private agents use the level of outstanding government commitment to forecast inflation. Although it is still optimal to smooth intratemporal distortions and let tax and inflation rates go up and down together, it is no longer optimal to smooth intertemporal distortions in the sense that tax and inflation rates must follow random walks. Instead, permanent increases in government spending are financed through building up government assets and generating interest income made possible through temporary bouts in inflation and taxation. The steady state is then characterised by no tax distortions, full liquidity and Friedman's optimum quantity of money. Given that all contracts are indexed, no case can be made for an independent central bank.

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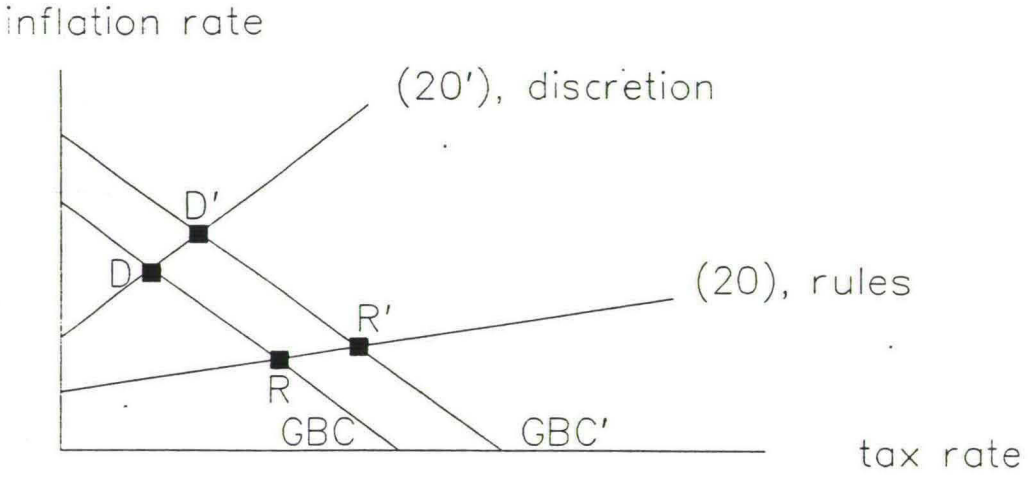

Figure 1:
Effects of higher government commitments under rules and discretion.

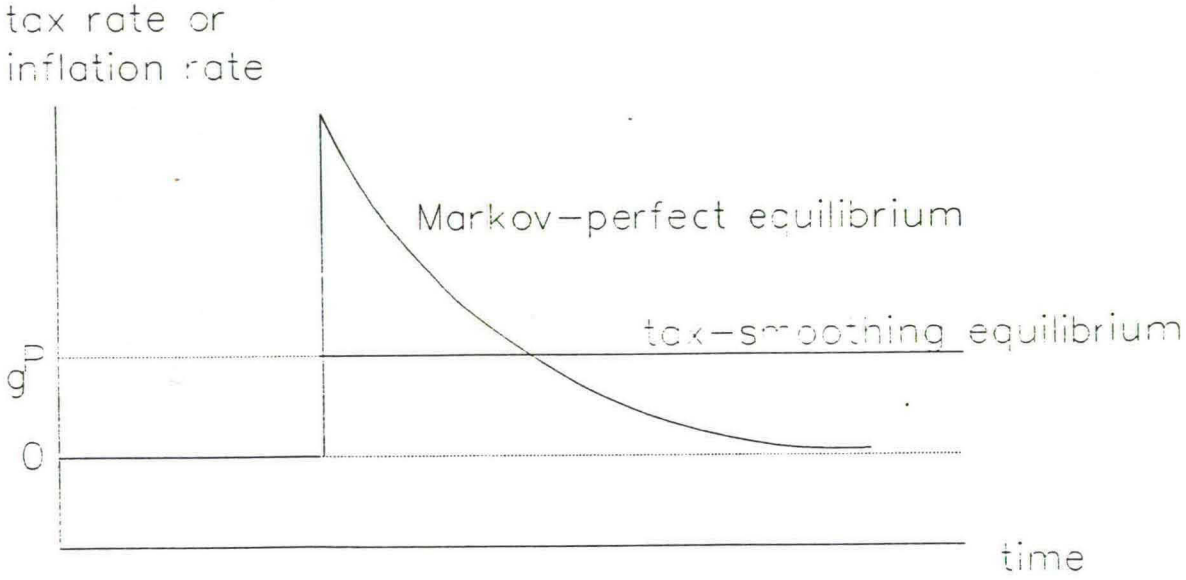

Figure 2:
Temporary bouts of inflation and taxation.

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